AMENDMENT TO THE CLAIMS

Claims 1-43 (**Cancelled**)

44.(New) A method of thermal analysis, wherein heating characteristic at any measuring point of an object at any measuring location of a heating furnace is determined as a single invariable by using temperature measured at the measuring point of the object and heating temperature and heating time at the measuring location of the heating furnace, which heating characteristic represents physical characteristics of both of the heating furnace and the object to be heated, wherein changes of said physical characteristics and/or defects of the heating furnace are detected by obtaining said invariable periodically and analyzing variance of said heating characteristic.

45.(New) A method according to claim 44, wherein changes of the physical characteristics and/or defects of a specific heating furnace are detected by obtaining said invariables from a plurality of heating furnaces and comparing said heating characteristics of said plurality of heating furnaces among each other.

46.(New) A method according to claim 44, wherein temperature profile of the object when the object is heated under given heating condition is simulated by using the invariable.

47.(New) A method according to claim 44, wherein appropriate heating condition of the heating furnace for heating the object in accordance with a required temperature profile is determined by using the invariable.

48.(New) A method according to claim 47, wherein appropriate heating condition for each of a plurality of heating sections structured in the heating furnace for heating the object in accordance with a required temperature profile are determined by using the

invariable obtained from at least one measuring location for each of the plurality of heating sections.

49.(New) A method according to claim 46, wherein said heating condition comprises either one of heating temperature, heating time, transfer speed of the object in the heating furnace, or blowing speed of heated air for heating the object, or any combination thereof.

50.(New) A method according to claim 44, wherein said heating furnace is either one of reflow furnace, heat treatment furnace, sintering furnace, baking oven, melting furnace, or incinerating equipment.

51.(New) A method according to claim 44, wherein said invariable is an m-value defined by:

$$m = \frac{1}{t} \ln \left[\frac{Ta - Tint}{Ta - Ts} \right]$$

wherein ln is natural logarithm, Ta is heating temperature of the measuring location of the heating furnace, Tint is initial temperature of the measuring point of the object at the measuring location, Ts is achieved temperature when the object is heated at the measuring location, and t is heating time at the measuring location.

52.(New) A method according to claim 51, wherein temperature Ts of the object is determined when heating temperature Ta and heating time t of the heating furnace are given, or heating temperature Ta and heating time t are determined when required temperature Ts is given by using said m-values based on a following basic equation for heating:

$$Ts = Ta - (Ta - Tint)\, e^{-m \cdot t}$$

wherein e in the equation represents the base of natural logarithms.

53.(New) A method according to claim 51, wherein said m-value is adjusted based on a predetermined equation of relationship between the blowing speed of the heated air and

the m-value when the blowing speed of the heated air of the heating furnace is changed.

54.(New) A method of thermal analysis for determining appropriate heating condition for heating an object in a heating furnace in accordance with a required temperature profile corresponding to predetermined required conditions for heating the object, wherein said method comprises steps of:

determining a sample object to be heated and heating condition of the heating furnace;

determining required conditions for heating the object;

heating the sample object, and measuring temperature of at least one measuring point of the sample object at a plurality of measuring locations of said heating furnace;

calculating heating characteristic value for each measuring point at each measuring location based on measured temperature of the measuring point as well as heating temperature and heating time at each measuring location;

modifying the heating condition by changing either one of or both of the heating temperature and the heating time of at least one of the measuring locations;

simulating temperature of each measuring point of the object at each measuring location of the heating furnace under the modified heating condition by using the corresponding heating characteristic values based on a basic equation for heating;

determining that the modified heating condition is appropriate for satisfying the required temperature profile when a temperature profile developed from the simulated temperature meets said required conditions, and

re-modifying the heating condition when the developed temperature profile does not meet said required conditions, and repeating the above procedures until the developed temperature profile meets the required conditions,

wherein said heating characteristic value is an m-value defined by:

$$m = \frac{1}{t} \ln\left[\frac{Ta - Tint}{Ta - Ts}\right]$$

wherein In is natural logarithm, Ta is heating temperature of the measuring location of the heating furnace, Tint is initial temperature of the measuring point of the object at the measuring location, Ts is achieved temperature when the object is heated at the measuring location, and t is heating time at the measuring location.

55.(New) A method of thermal analysis for determining appropriate heating condition for heating an object in a heating furnace having a plurality of heating sections in accordance with a required temperature profile corresponding to predetermined required conditions for heating the object, wherein said method comprises steps of:

determining a sample object to be heated and heating condition of each heating section of the heating furnace;

determining required conditions for heating the object;

heating the sample object, and measuring temperature of at least one measuring point of the sample object at at least one measuring location of each of the heating sections of the heating furnace;

calculating heating characteristic value for each measuring point at each measuring location based on the measured temperature of the measuring point as well as heating temperature and heating time at each measuring location;

modifying the heating condition by changing either one of or both of the heating temperature and the heating time of at least one of the heating sections;

simulating temperature of each measuring point of the object at each measuring location of the heating furnace under the modified heating condition by using the corresponding heating characteristic values based on a basic equation for heating;

determining that the modified heating condition is appropriate for satisfying the required temperature profile when a temperature profile developed from the simulated temperature meets said required conditions, and

re-modifying the heating condition when the developed temperature profile does not meet said required conditions, and repeating the above procedures until the developed temperature profile meets the required conditions,

wherein said heating characteristic value is an m-value defined by:

$$m = \frac{1}{t} \ln\left[\frac{Ta - Tint}{Ta - Ts}\right]$$

wherein In is natural logarithm, Ta is heating temperature of the measuring location of the heating furnace, Tint is initial temperature of the measuring point of the object at the measuring location, Ts is achieved temperature when the object is heated at the measuring location, and t is heating time at the measuring location.

56.(New) A method according to claim 54, wherein said heating furnace is either one of reflow furnace, heat treatment furnace, sintering furnace, baking oven, melting furnace, or incinerating equipment.

57.(New) A method of thermal analysis for determining appropriate heating condition for heating an object comprising a circuit substrate having printed solder thereon while the object is transferred in a heating furnace having a plurality of heating sections, forming a preheat stage and a reflow stage in accordance with a required temperature profile corresponding to predetermined required conditions for heating the object, wherein said method comprising steps of:

determining a sample object to be heated and heating condition of each heating section of the heating furnace;

determining required conditions for heating the object in both of the preheat stage and the reflow stage;

heating the sample object, and measuring temperature of at least one measuring point of the sample object at at least one measuring location of each of the heating sections of the heating furnace;

calculating heating characteristic value for each measuring point at each measuring location based on measured temperature of the measuring point as well as heating temperature and heating time at each measuring location;

modifying the heating condition by changing either one of or both of the heating temperature and the heating time of at least one of the heating sections;

simulating temperature of each measuring point of the object at each measuring location of the heating furnace under the modified heating condition by using the corresponding heating characteristic values based on a basic equation for heating;

determining that the modified heating condition is appropriate for satisfying the required temperature profile when a temperature profile developed from the simulated temperature meets said required conditions of both of the preheat stage and the reflow stage, and

re-modifying the heating condition when the developed temperature profile does not meet said required conditions of the preheat stage or the reflow stage, and repeating the above procedures until the developed temperature profile meets the required conditions, wherein said heating characteristic value is an m-value defined by:

$$m = \frac{1}{t} \ln\left[\frac{Ta - Tint}{Ta - Ts}\right]$$

wherein In is natural logarithm, Ta is heating temperature of the measuring location of the heating furnace, Tint is initial temperature of the measuring point of the object at the measuring location, Ts is achieved temperature when the object is heated at the measuring location, and t is heating time at the measuring location.

58.(New) A method according to claim 57, wherein the method further comprises steps of:

verifying the heating condition which has met the predetermined required conditions through simulation by actually heating the sample object under the same heating condition and measuring temperature at each measuring point of the sample object at each measuring location of said heating furnace, before determining that such heating condition is appropriate for satisfying the required temperature profile;

determining that the verified heating condition is appropriate for satisfying the required temperature profile when a temperature profile developed at the verification step

meets the required conditions, and

re-calculating the heating characteristic value for each measuring point at each measuring location based on the results of the verification step when the developed temperature profile at the verification step does not meet the required conditions, and repeating the above procedures until the developed temperature profile meets the required conditions.

59.(New) A method according to claim 54, wherein the basic equation for heating is defined by:

$Ts=Ta-(Ta-Tint)\,e^{-m\cdot t}$

wherein Ta is heating temperature of the measuring location of the heating furnace, Tint is initial temperature of the measuring point of the object at the measuring location, Ts is achieved temperature when the object is heated at the measuring location, t is heating time at the measuring location, m is the corresponding heating characteristic value, and e is the base of natural logarithms.

60.(New) A method according to claim 54, wherein said required conditions for heating the object includes either one of, or any combination of:

(a) targeted heating temperature and heating time for keeping the object at a certain temperature for a certain length of time so as to achieve the purpose of heating;

(b) required upper end temperature that the object needs to achieve during heating;

(c) maximum temperature, which is the temperature the object should not go over for sustaining its function;

(d) allowable limited temperature and time that the object may endure during heating process;

(e) preheat temperature and time required for heating the object prior to heating for the ultimate purpose, and

(f) allowable temperature variation among a plurality of measuring points of the object.

61.(New) A program for making a computer to process steps of determining appropriate heating condition of a heating furnace having a plurality of heating sections for heating an object in accordance with a required temperature profile corresponding to predetermined required conditions for heating the object, said steps comprising:

obtaining heating characteristic value of at least one measuring location of each of said plurality of heating sections calculated from heating temperature and heating time at said measuring location as well as measured temperature of at least one measuring point of the object when the object is heated under certain heating condition at said measuring location,

electing one measuring point which has achieved the highest temperature during the heating among all the measuring points, and confirming whether temperature of the elected measuring point is not over the upper limit of the required conditions (confirmation step A);

when temperature of the elected measuring point is over the required conditions at the confirmation step A, modifying the heating condition by lowering the heating temperature based on a predetermined rule and simulating temperature at each measuring point under the modified heating condition by using the corresponding heating characteristic value, and repeating the above procedures from the confirmation step A;

when temperature of the elected measuring point is not over the required conditions at the confirmation step A, confirming whether or not the elected measuring point meets heating time of the required conditions (confirmation step B);

when the heating time of the elected measuring point falls short of the required conditions at the confirmation step B, modifying the heating condition by raising the heating temperature based on a predetermined rule or by lengthening the heating time based on a predetermined rule and simulating temperature for each measuring point under the modified heating condition by using said corresponding heating characteristic value, and repeating the above procedures from the confirmation step A;

when the heating time of the elected measuring point goes over the required conditions at the confirmation step B, modifying the heating condition by lowering the

heating temperature based on a predetermined rule or by shortening the heating time based on a predetermined rule and simulating temperature for each measuring point under the modified heating condition by using the corresponding heating characteristic value, and repeating the above procedures from the confirmation step A;

when the heating time of the elected measuring point meet the required conditions at the confirmation step B, confirming whether or not all the other measuring points meet the required conditions (confirmation step C);

when any one of the measuring points does not meet the required conditions at the confirmation step C, modifying the heating condition by lengthening the heating time based on a predetermined rule or by raising the heating temperature based on a predetermined rule and simulating temperature for each measuring point under the modified heating condition by using the corresponding heating characteristic value, and repeating the above procedures from the confirmation step A;

when all the measuring points meet the required conditions at the confirmation step C, determining that such heating condition is appropriate for satisfying the required temperature profile,

wherein the program further includes a logic of making a judgment that determining appropriate heating condition for heating the object in accordance with the required temperature profile is impossible when number of repeating procedures in a closed loop at any of the confirmation steps A-C exceeds a predetermined times.

62.(New) A program for making a computer to process steps of determining appropriate heating condition of a heating furnace having a plurality of heating sections for heating an object in accordance with a required temperature profile corresponding to predetermined required conditions for heating the object, said steps comprising:

obtaining heating characteristic value of at least one measuring location of each of said plurality of heating sections calculated from heating temperature and heating time at said measuring location as well as measured temperature of at least one measuring point of the object when the object is heated under certain heating condition at said measuring

location,

electing one measuring point, as a critical measuring point, which has achieved the lowest temperature during the heating among all the measuring points,

detecting heating condition of each of the heating sections which may make said critical measuring point to satisfy both of the required upper end temperature that the object needs to achieve and the maximum temperature that the object should no go over, by simulating temperature of the critical measuring point by using the corresponding heating characteristic value for each of the measuring locations based on a predetermined algorithm,

confirming whether any of the detected heating conditions at the detecting step meet targeted heating temperature and heating time that the object needs to clear for fulfilling the purpose of heating (confirmation step D);

when none of the detected heating conditions meet the targeted heating temperature and heating time at the confirmation step D, modifying the heating condition by lengthening the heating time based on a predetermined rule and simulating temperature at each measuring point under the modified heating condition by using the corresponding heating characteristic value, and repeating the above procedures from the step of electing the critical measuring point;

when any of the detected heating conditions meet the targeted heating temperature and heating time at the confirmation step D, confirming whether such detected heating condition(s) meet other required conditions of allowable limited temperature and time that the object may endure during heating (confirmation step E);

when none of the detected heating condition(s) meet the allowable limited temperature and time at the confirmation step E, modifying the heating condition by shortening the heating time based on a predetermined rule and simulating temperature at each measuring point under the modified heating condition by using the corresponding heating characteristic value, and repeating the above procedures from the step of electing the critical measuring point;

when any one of the detected heating condition(s) meet the allowable limited temperature and time at the confirmation step E, temporarily electing one detected heating condition that has cleared the allowable limited temperature and time requirement by the shortest time among all the detected heating condition(s) as the appropriate heating condition for satisfying the required temperature profile;

confirming whether all the other measuring points meet the required conditions by simulating temperatures under the temporarily elected heating condition by using the corresponding heating characteristic values of the other measuring points (confirmation step F);

when none of the measuring points meet the required conditions at the confirmation step F, modifying the temporarily elected heating condition by shortening heating time based on a predetermined rule and simulating temperature of each measuring point under the modified heating condition by using the corresponding heating characteristic value, and repeating the above procedures from the step of electing the critical measuring point, and

when all the measuring points meet the required conditions at the confirmation step F, determining that the temporarily elected heating condition is appropriate for satisfying the required temperature profile,

wherein when none of heating conditions for the critical measuring point could meet the targeted heating temperature and time requirement at the confirmation step D during the course of the repeated procedures after it was found at the confirmation step F that none of the measuring points meet the required conditions of the second heating stage, and modification of the heating condition was made by shortening heating time, the program further includes a logic of determining approximately appropriate heating condition by lengthening the heating time of the latest temporarily elected heating condition based on a predetermined rule.

63.(New) A program for making a computer to process steps of determining appropriate heating condition of a heating furnace having a plurality of heating sections forming a first and a second heating stages for heating an object in accordance with a

required temperature profile corresponding to predetermined required conditions for each of the first and the second stages, said steps comprising: obtaining heating characteristic value for at least one measuring location of each of said plurality of heating sections calculated from heating temperature and heating time at said measuring location as well as measured temperature of at least one measuring point of the object when the object is heated under certain heating condition at the measuring location,

electing one measuring point which has achieved the highest temperature during heating at the first heating stage among all the measuring points, and confirming whether temperature of the elected measuring point is not over the upper limit of the required conditions (confirmation step A);

when temperature of the elected measuring point is over the required conditions of the first heating stage at the confirmation step A, modifying the heating condition by lowering the heating temperature based on a predetermined rule and simulating temperature at each measuring point under the modified heating condition by using the corresponding heating characteristic value, and repeating the above procedures from the confirmation step A;

when temperature of the elected measuring point is not over the required conditions of the first heating stage at the confirmation step A, confirming whether or not the elected measuring point meets heating time of the required conditions of the first heating stage (confirmation step B);

when the heating time of the elected measuring point falls short of the required conditions of the first heating stage at the confirmation step B, modifying the heating condition by raising the heating temperature based on a predetermined rule or by lengthening the heating time based on a predetermined rule and simulating temperature for each measuring point under the modified heating condition by using the corresponding heating characteristic value, and repeating the above procedures from the confirmation step A;

when the heating time of the elected measuring point goes over the required conditions of the first heating stage at the confirmation step B, modifying the heating

condition of the first heating stage by lowering the heating temperature based on a predetermined rule or by shortening the heating time based on a predetermined rule and simulating temperature for each measuring point under the modified heating condition by using the corresponding heating characteristic value, and repeating the above procedures from the confirmation step A;

when the heating time of the elected measuring point meet the required conditions of the first heating stage at the confirmation step B, confirming whether or not all the other measuring points meet the required conditions of the first heating stage (confirmation step C);

when any one of the measuring points does not meet the required conditions of the first heating stage at the confirmation step C, modifying the heating condition by lengthening the heating time of the first heating stage based on a predetermined rule or by raising the heating temperature of the first heating stage based on a predetermined rule and simulating temperature for each measuring point under the modified heating condition by using the corresponding heating characteristic value, and repeating the above procedures from the confirmation step A;

when all the measuring points meet the required conditions for the first heating stage at the confirmation step C, electing one measuring point, as a critical measuring point, which has achieved the lowest temperature at the second heating stage during heating among all the measuring points;

detecting heating condition of each of the heating sections in the second heating stage which may make said critical measuring point to satisfy both of the required upper end temperature that the object needs to achieve and the maximum temperature that the object should no go over, by simulating temperature of the critical measuring point by using the corresponding heating characteristic value for each of the measuring locations in the second heating stage based on a predetermined algorithm,

confirming whether or not any of the detected heating conditions at the detecting step meet targeted heating temperature and heating time that the object needs to clear for fulfilling the purpose of heating (confirmation step D);

when none of the detected heating conditions meet the targeted heating temperature and heating time at the confirmation step D, modifying the heating condition by lengthening the heating time based on a predetermined rule and simulating temperature at each measuring point under the modified heating condition by using the corresponding heating characteristic value, and repeating the above procedures either from the step of electing the critical measuring point or from the confirmation step A;

when any one of the detected heating conditions meet the targeted heating temperature and heating time at the confirmation step D, confirming whether such detected heating condition(s) meet other required conditions of allowable limited temperature and time that the object may endure during heating (confirmation step E);

when none of the detected heating condition(s) meet the allowable limited temperature and time at the confirmation step E, modifying the heating condition by shortening the heating time based on a predetermined rule and simulating temperature at each measuring point under the modified heating condition by using the corresponding heating characteristic value, and repeating the above procedures either from the step of electing the critical measuring point or from the confirmation step A;

when any one of the detected heating condition (s) meet the allowable limited temperature and time at the confirmation step E, temporarily electing one detected heating condition that has cleared the allowable limited temperature and time requirement by the shortest time among all the detected heating condition(s) as the appropriate heating condition for satisfying the required temperature profile;

confirming whether all the other measuring points meet the required conditions of the second heating stage by simulating temperatures under the temporarily elected heating condition by using the corresponding heating characteristic values of the other measuring points (confirmation step F);

when any of the measuring points do not meet the required conditions of the second heating stage at the confirmation step F, modifying the temporarily elected heating condition by shortening heating time based on a predetermined rule and simulating temperature of each measuring point under the modified heating condition by using the

corresponding heating characteristic value, and repeating the above procedures either from the step of electing the critical measuring point or from the confirmation step A; and

when all the measuring points meet the required conditions for the second heating stage at the confirmation step F, determining that the temporarily elected heating condition is appropriate for satisfying the required temperature profile.

64.(New) A program according to claim 63, wherein when none of heating conditions for the critical measuring point could meet the targeted heating temperature and time requirement at the confirmation step D during the course of the repeated procedures after it was found at the confirmation step F that none of the measuring points meet the required conditions of the second heating stage, and modification of the heating condition was made by shortening heating time, the program further includes a logic of determining approximately appropriate heating condition by lengthening the heating time of the latest temporarily elected heating condition based on a predetermined rule.

65.(New) A program according to claim 63, wherein the program further includes a logic of making a judgment that determining appropriate heating condition for heating the object in accordance with the required temperature profile is impossible when number of repeating procedures in a closed loop at any of the confirmation steps A-F exceeds a predetermined times.

66.(New) A program according to claim 63, wherein said heating characteristic value is an m-value defined by:

$$m = \frac{1}{t} \ln\left[\frac{Ta - Tint}{Ta - Ts}\right]$$

wherein In is natural logarithm, Ta is heating temperature of the measuring location of the heating furnace, Tint is initial temperature of the measuring point of the object at the measuring location, Ts is achieved temperature when the object is heated at the measuring

location, and t is heating time at the measuring location, and simulating temperature of each of measuring point using the corresponding heating characteristic value is made based on a following basic equation for heating:

$Ts=Ta-(Ta-Tint)\,e^{-m\cdot t}$

wherein e in the equation represents the base of natural logarithms.

67.(New) A program according to claim 63, wherein the predetermined rule for lowering the heating temperature when temperature of the elected measuring point is over the required conditions at the confirmation step A is either lowering the heating temperature down to the upper end temperature of the allowable range of the required heating conditions, or lowering the heating temperature by an amount obtained by multiplying a certain ratio to a temperature difference identified between the measured or simulated temperature and the upper end temperature of the allowable range.

68.(New) A program according to claim 63, wherein the predetermined rule for raising or lowering the heating temperature when heating time of the elected measuring point falls short of or goes over the required conditions at the confirmation step B is either raising or lowering the heating temperature of the particular heating section(s) by a predetermined amount, which particular heating section(s) are those located in advance of the heating section where temperature of the elected measuring point reaches the allowable range of the required conditions.

69.(New) A program according to claim 63, wherein the predetermined rule for lengthening heating time when any one of the measuring points does not meet the required conditions at the confirmation step C is to multiply preceding transfer speed of the object with a ratio closest to 1 among the ratios of required heating time versus measured or simulated heating time for each of the measuring points which failed to meet the required conditions, or to divide the preceding heating time by the same ratio.

70.(New) A program according to claim 63, wherein the predetermined algorithm for detecting heating conditions for making the critical measuring point to satisfy both of the required upper end temperature and the maximum temperature is configured by the steps of:

creating combinations of heating condition of at least two heating sections by raising respective heating temperatures independently by every predetermined amount from the initial temperature of the object at the beginning of the heating section up to a predetermined upper limit temperature defined by the heating furnace;

simulating temperature of the critical measuring point under each of the created combinations of the heating condition, and developing temperature profiles corresponding to each of the combinations of the heating condition; and detecting any of the combinations of the heating condition which may make the corresponding simulated temperature to locate inside a zone defined by said at least two heating sections, which zone is surrounded by an upper boundary and a lower boundary, wherein the upper boundary comprising an temperature increase line between a point H of an initial temperature of the preceding heating section and a point E of the maximum temperature at the end of the same heating section as well as a line of the maximum temperature between said point E and a point G at the end of said at least two heating sections, while the lower boundary comprising a line between said point H and a point F of the required upper end temperature at the end of said at least two heating sections.

71.(New) A program according to claim 63, wherein the predetermined rule for lengthening the heating time when none of the heating conditions meet the required time conditions at the confirmation step D is to multiply preceding transfer speed of the object with a ratio closest to 1 among the ratios of the heating time at the targeted heating temperature versus corresponding simulated time for each of the measuring points which failed to meet the required conditions, or to divide the preceding heating time by the same ratio.

72.(New) A program according to claim 63, wherein the predetermined rule for shortening the heating time when none of the heating conditions meet the required time conditions at the confirmation step E is to multiply preceding transfer speed of the object with a ratio closest to 1 among the ratios of heating time at the allowable limited temperature versus corresponding simulated time for each of the measuring points which failed to meet the required conditions, or to divide the preceding heating time by the same ratio.

73.(New) A program according to claim 63, wherein the predetermined rule for shortening the heating time when any of the heating conditions do not meet the required conditions at the confirmation step F is to multiply preceding transfer speed of the object with a ratio closest to 1 among the ratios of the heating time at the targeted heating temperature versus corresponding simulated time, or among the ratios of the heating time at the allowable limited temperature versus corresponding simulated time for each of the measuring points which failed to meet the required condition, or to divide the preceding heating time by the same ratio.

74.(New) A program according to claim 63, wherein in addition to overall required conditions for heating the object which are to be applied equally to any part of the object, individual required conditions are separately determined which are to be applied to corresponding each of the measuring points of the object individually, and the program further includes a logic for making a judgment that even if the heating condition does not meet some requirements of the overall required conditions at some measuring points, such heating conditions are deemed appropriate as far as said individual required conditions to be applied to those particular measuring points are satisfied.

75.(New) A computer readable recording medium recording a program for making a computer to process steps of determining appropriate heating condition for heating an object in accordance with a required temperature profile corresponding to required conditions for heating the object, wherein said program is defined by claim 63.

76.(New) An apparatus for performing thermal analysis to be used for heating an object in a heating furnace, comprising a input means, a memory and a processor,

wherein said input means obtains information of heating temperature and heating time of the heating furnace and temperature of the object,

said memory stores a logic for calculating heating characteristic value, and a basic equation for heating or a logic for calculating temperature of the object to be heated by using said heating characteristic value as well as the heating temperature and heating time, and

said processor calculates either said heating characteristic value or temperature of the object corresponding to the heating temperature and the heating time, by using said logics and said basic equation for heating stored in the memory.

77.(New) An apparatus according to claim 76, wherein the apparatus further comprises a reading means for reading recording medium, wherein the processor determines appropriate heating condition including heating temperature and heating time, which may satisfy the required conditions of the object to be heated, by using the required conditions for heating the object obtained by the input means, algorithm that the reading means obtained by reading the recording medium, and the heating characteristic value calculated by the processor.

78.(New) An apparatus according to claim 76, wherein said heating characteristic value is an m-value defined by:

$$m = \frac{1}{t} \ln\left[\frac{Ta - Tint}{Ta - Ts}\right]$$

wherein In is natural logarithm, Ta is the heating temperature, Tint is initial temperature of the object, Ts is achieved temperature when the object is heated, and t is the heating time.

79.(New) An apparatus according to claim 76, wherein said basic equation for heating is defined by:

$Ts=Ta-(Ta-Tint)\,e^{-m\cdot t}$

wherein Ta is the heating temperature, Tint is initial temperature of the object, Ts is achieved temperature when the object is heated, t is the heating time, e is the base of natural logarithms, and m is the heating characteristic value.

80.(New) A heat controller for determining appropriate heating condition including heating temperature and heating time for each of heating sections structured in a heating furnace, and for controlling the heating furnace based on such determined appropriate heating condition so as to heat an object in accordance with a required temperature profile corresponding to required conditions for heating the object, said controller comprising an input means, an output means, a memory, a processor and a reading means for reading recording media,

wherein the controller controls the heating furnace by reading recording medium defined by claim 75.

81.(New) A heating furnace for heating an object introduced into the furnace in accordance with a required temperature profile corresponding to required conditions for heating the object, said heating furnace comprising at least one heating section, a heat source provided to each of the heating sections for heating the object, and a heat controller capable of controlling heating condition for each of the heating sections,

wherein said heat controller is defined by claim 80.

82.(New) A heating furnace according to claim 81, wherein said heating furnace is either one of reflow furnace, heat treatment furnace, sintering furnace, baking oven, melting furnace, and incinerating equipment.

83.(New) A method of thermal analysis, wherein cooling characteristic of at least one measuring point of an object at one measuring location of a cooling equipment is determined as a single invariable by using temperature measured at said at least one measuring point of the object as well as cooling temperature and cooling time at the at least one measuring location of the cooling apparatus, which cooling characteristic represents physical characteristics of both of the cooling equipment and the object to be cooled, wherein appropriate cooling condition of a cooling equipment for cooling the object in accordance with a required temperature profile is determined by using the determined invariables.